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## REMARKS.

No. 15. Found searching for Comet 1889 BROOKS after POOR's ephemeris; saw it again June 10, 1896.

No. 33. Found searching for BROOKS's comet 1889.

No. 34. Found searching for BROOKS's comet 1889.

No. 41. Neither this nor the four preceding nebulae are in N. G. C. No. 38 may possibly = No. 1459 of DREYER's index catalogue.

IS *MARS* INHABITED?

BY PROFESSOR C. A. YOUNG.

For some reason not quite obvious to the professional astronomer, there seems to be an extreme popular interest in the question of the habitability of "other worlds," and of late it has been greatly intensified by the rather sensational speculations and deliverances of FLAMMARION, LOWELL, and others—speculations based upon new discoveries reported within the last ten or fifteen years, some of which are doubtless real, while others are still more or less questionable.

The editor of the *Herald* has done me the honor to ask me to say to his readers what I think about the matter, and I accept the invitation with pleasure.

I may as well say at the outset that in my judgment we have not yet any satisfactory basis for a confident opinion. The available data are insufficient, and, what is worse, they in some cases seem to indicate opposite conclusions.

As to the general question whether the stars and planets are the abodes of life, we can, of course, say positively on the one hand that they may be. Plainly the Omnipotent Deity can, if He sees fit, organize forms of life suited to any possible conditions, creatures that might flourish in the solar fire, or in nebular fog. On the other hand, there is not the slightest valid evidence that such creatures exist. Considering the "vast emptinesses" between the stars, and the lifeless ages of the Earth's early history, as revealed by geology, one cannot argue that material globes must be inhabited. Unoccupied space, lifeless millenniums, and worlds uninhabited all fall into the same category of unexplained use.

But if we narrow the question, and inquire as to the possibility of forms of life such as we are acquainted with upon the Earth, the case is different. We are able to say at once, and with absolute confidence, that there are only two among all the heavenly bodies observable with our present telescopes upon which anything like terrestrial life could possibly exist. The two are *Venus* and *Mars*; upon all the rest the conditions are clearly too different from our own.

But the limitation must not be lost sight of—there may be, and very likely there are, circulating around some of the distant suns, planets not very unlike the Earth and well enough suited for even human life. But if such planets exist we cannot see them with any telescope yet constructed or ever likely to be. To make them visible would require lenses from 50 to 100 feet in diameter.

Speculation may be allowable in the premises, but dogmatism certainly is not.

As to the planet *Venus*, we need say very little here. In diameter, mass, density, and the force of gravity upon her surface, she is the Earth's twin sister. She is so much nearer than we are to the Sun that she receives from him almost twice as much heat and light as we do; but as to the character of her surface we know almost nothing. Unquestionable observations prove that she has a denser atmosphere than ours, and it is probably always filled with cloud.

At any rate, no distinct and well-marked features have ever been detected on her surface, and there is no reason to suppose that the cloud veil has ever lifted.

With *Mars* the case is different; we know more about him than we do about any other heavenly body, the Moon excepted.

We may reckon up our stock of certain knowledge about this planet somewhat as follows:

In the first place, its orbit is about once and a half as large as the Earth's, and it makes its circuit in 687 days, at a distance from the Sun which ranges between 128,000,000 and 150,000,000 miles, the mean being 141,500,000. Once in every 730 days the Earth overtakes it, passing between it and the Sun; and if this happens in the latter part of August, the distance between us will be the least possible—only about 35,000,000 miles.

No other heavenly body except the Moon and *Venus*, and now and then a comet, ever come so near.

Still this is not so very near after all. Thirty-five million miles is 147 times the distance of the Moon. So that, even with a magnifying power of a thousand (and only the largest telescopes, under the most favorable conditions, can ever use so high a power to advantage), we see the planet's surface just as we view the Moon through a common field-glass magnifying seven times. And most of our observations are made, of course, at a distance much greater than this minimum.

Moreover, since the planet's distance from the Sun averages something more than once and a half that of the Earth, it is certain that *Mars* receives less than half as much solar heat and light as we do—an unquestionable and most important fact.

In the next place, we know that the diameter of *Mars* is about 4200 miles (somewhat more than half that of the Earth), and that it rotates in 24 hours, 37 minutes, 22.65 seconds around an axis so situated that the planet's equator is inclined about twenty-four degrees to the plane of its orbit. This is so nearly the same as the inclination of the Earth's equator, that we may safely infer that *Mars* must have seasons very like those of the Earth, though notably modified by the considerable variations in its distance from the Sun at different parts of its orbit.

In the third place, from the motions of its two little Moons, we can calculate with certainty the weight or "mass" of the planet, and we find it to be less than one-ninth (3-28) that of the Earth. From this it follows also that the planet's average density is seventy-two per cent. that of the Earth; and the force of gravity upon its surface is not quite thirty-eight per cent. as great as here.

A man who here weighs 160 pounds would there weigh only sixty pounds. If he were able here to jump to a height of five feet, there he would jump thirteen. So far as this condition goes, a Martian elephant might be as agile as a terrestrial deer.

Thus far there is no guesswork. We have stated knowledge, not speculation.

Once more. There are clear indications of an atmosphere upon the planet, though they are not such as to enable us to calculate with certainty its extent and density. This atmosphere ought to be much less extensive and dense than ours, on account of the lessened force of gravity, and if the so-called "dynamical theory" of gases, now almost universally accepted among physicists, is true, it must be a little body, like the Moon, or *Mars* cannot permanently retain an atmosphere like our own.

The inference is borne out, too, by the fact that clouds are only rarely observed upon the planet. As a rule we see the features of its surface unveiled and clear. There is probably never a time when a distant observer would be able to see half the seas and continents of the Earth unclouded and exposed to view.

Whether the Martian atmosphere contains any sensible quantity of water vapor is still a debated point. Some of the earlier observers reported that they could distinctly make out the characteristic lines of this substance in the planet's spectrum, but some of the best recent observers, notably Professor CAMPBELL, of the Lick Observatory, have reached an opposite conclusion.

And now we come to a question of great difficulty — that of the planet's temperature.

Since the planet's atmosphere is certainly not dense, it is natural to conclude that the temperature at its surface, even if the Sun's heat there were as intense as here, must be practically the same as that of places on the Earth where the density of the air is correspondingly low, namely, at the tops of the loftiest mountains, in the regions of perpetual snow.

And, recalling that on *Mars* the solar radiation is less than half as intense as here, the inference is almost irresistible that the temperature must be appallingly low—so low that, as on the Moon, water, if it exists at all, can exist only as ice.

And yet, while many astronomers—I myself, for one—are disposed to think this probably true, it is only an inference, and not a certain one. Nor can it be denied, as we shall see, that phenomena observed upon the planet look very much like the deposit and melting of polar snows, the flow of water, and the growth of vegetation.

It may be, perhaps, as FLAMMARION has suggested, that the planet's atmosphere, though rare, has some peculiar constitution that makes it more effective as a "blanket" than our own in its power to retain the solar heat; or it may possibly have some unknown source of heat; or again it may be that FAYE's modification of the nebular hypothesis is correct, and that *Mars*, instead of being an older planet than the Earth, as commonly supposed, may be a younger one, still retaining considerable of its original heat of condensation, and not yet cooled down to a permanent temperature corresponding to its distance from the Sun.

But unless some cause operates to give it an abnormal temperature, the discussion need go no further. Life resembling that upon the Earth could not exist there.

The time may come, perhaps, before very long, when we may have heat-measuring instruments of sufficient delicacy to give us certain information whether the planet's temperature is below zero, or is similar to that of our habitable earth. Till then judgment hangs suspended.

As a telescopic object, *Mars* is fine. Its ruddy disk is diversified with patches of greenish hue, which, in a small telescope, seem to form a sort of irregular belt around its equator, with several projecting angles which thrust themselves down into the northern hemisphere. The telescope inverts the planet much as South America and Africa and India reach toward the south upon a terrestrial globe.

These dark regions cover about a third of the ball, and, until recently, have generally been interpreted as seas and oceans, and are named accordingly. But later observations make this very doubtful by showing such changes in their form and appearance, and such markings upon them as to suggest rather that they are areas covered with vegetation.

Then, near one or the other of the poles, there is usually a "polar cap" of dazzling whiteness, and these caps grow and wane with the planet's seasons (as the elder HERSCHEL discovered more than a century ago), just as they would do if they were composed of ice and snow. Sometimes, also, though rarely, as has been already said, there are whitish veils of cloud that obscure for a time the well-known features, and shortly vanish. All the time the planet whirls, and as the night wears on continents and seas pass slowly in review, coming up from the eastern edge of the disk and descending upon the western.

If the telescope is powerful enough, HALL's two little Moons will be seen—*Phobos*, hurrying from one side to the other, close to the planet, and so rapidly that it takes him only three hours and three-quarters to make the whole excursion, while the smaller and more distant *Deimos* is more than four times as deliberate in his motion.

But the most interesting objects, if one can see them—for they require a keen eye, a first-rate instrument, and perfect atmospheric conditions—are the fine, dark, thread-like lines which cross the ruddy portions of the disk in various directions, in a most curious and suggestive manner. A few of them were noted (as rather ill-defined shadings), long ago, but it was SCHIAPARELLI, the Milanese astronomer, who, in 1887, first discovered them in

any number, and named them "the canals," as resembling water-courses of some sort, running from sea to sea.

As to their real nature, there is still much doubt. Those who ignore the temperature difficulty, and believe that the polar caps are really sheets of snow which melt in the summer, for the most part accept the suggestion which the names implies, and regard them as marking the track of channels, natural or artificial, through which the water that results from the melting of the ice-caps is distributed over the arid plains near the planet's equator. They suppose—at least, this is the view of FLAMMARION and LOWELL,—that what we see is not the water-course itself, but the fringe of vegetation, which springs up along its banks when the water comes, like the harvests of the valley of the Nile.

And this certainly accords very well with the fact that these canals are not equally visible at all times, but are sometimes fairly conspicuous, while they vanish at others.

Possibly, too, one might deduce from this theory a satisfactory explanation of a very strange phenomenon exhibited by many of them—their "gemination," as it is called. They double themselves at times. A canal which had been a single, thin, dark line is replaced in a day or two by two that are exactly parallel and separated by a distance of from 100 to 250 miles. Some of these canals are over 2000 miles in length, and appear to be as accurately straight as lines can be upon a sphere. They seem to follow a true great circle course.

At their points of intersection—and in several instances, as many as half a dozen seem to converge as accurately to a single point as railroads to a city—small dark spots appear, which have received the name of "lakes." Mr. Lowell, however, prefers to call them "oases," believing them to be patches of vegetation which are formed where the converging channels bring an especially abundant supply of moisture.

And the fact that, according to SCHIAPARELLI and the Flag-staff observers, some of the canals appear to invade, and pass across, the so-called "seas," of course, proves, unless there is some error or illusion in the observations, that these darkly shaded regions are not bodies of water, but marshes, fields, or forests.

We should have noted, as removing a natural objection to this water-course theory of the "canals," that so far as can be judged from observations, the planet's surface is much more level than

that of the Earth. There is no evidence of lofty mountain ranges, though a few projecting bright spots have been noted at the boundary of day and night on the planet's surface, which may indicate elevations having the height of two or three thousand feet.

And it is to be admitted also, I think, that no other explanation of the "canals" as yet proposed satisfies the reported appearances so well as that of water-courses. The only one not absolutely contradicted by direct observations is that they are fissures and wrinkles in the planet's crust, produced by its shrinkage over a comparatively unyielding nucleus. But, then, what is to be made of their "gemination"?

We have thus set forth the conditions of the planet so far as they appear to bear upon its possible habitability by living beings, resembling in essential characteristics those that inhabit the Earth. If we put aside, as FLAMMARION and LOWELL have done, rather airily, we think, the serious difficulty as to temperature, and assume with them that the planet's water-supply is extremely scanty—which can hardly be doubted, if water exists there at all,—and that the planet's surface, for the most part an arid waste, is to some extent made fertile by the channels which distribute the water derived from the melting polar snow-caps, it is clear that we have a condition of affairs which might make habitability of the sort contemplated a not absurd hypothesis.

And yet the great difference between the Earth and *Mars* as to thinness of the atmosphere, the absence of clouds, and the lessened force of gravity and solar radiation must necessitate a wide difference between the inhabitants of the two worlds.

Next comes the question whether, granting the possibility of life upon the planet, we have any evidence of its existence.

As regards vegetable life, its existence is, of course, assumed in the very plausible explanation which LOWELL and FLAMMARION give of the "canals," and the seasonal changes observed in the features of the planet's disc. And they go further. Mr. LOWELL finds evidence of intelligent design and engineering skill in the—according to him—perfect straightness of the long water-courses and the precision with which numbers of them converge to or diverge from certain centers. And he enters into interesting speculations as to the ability of the people of *Mars* to perform feats of engineering quite beyond our human powers.

In the first place, owing to the feebleness of gravity there, the

“men” of *Mars* might attain a strength and stature nearly three times as great as ours without encumbrance from their own weight, and dealing, as they would have to, with rocks only a little more than a third as heavy as they would be here, their work would be greatly more effective.

Then, too, LOWELL, basing his speculation upon the generally received form of the nebular hypothesis (which, contrary to FAYE’s theory, makes *Mars* an older world than ours), argues that the Martians already possess the engineering skill, machines, and appliances which we shall have upon the earth some ages hence.

Human beings may then find themselves upon a world nearly dried up, and may have to undertake irrigation on a scale suggested by what we see upon our neighbor.

Both LOWELL and FLAMMARION remind us, however, very properly, that we must beware of assuming that the “men” of *Mars*—its intelligent inhabitants—are vertebral bipeds like ourselves. If intelligent beings exist there, the probabilities are strong that they are very different from us in ways which we can hardly conjecture, since the difference between the Earth and *Mars* in physical conditions must almost necessarily have determined different lines of development on the two planets. FLAMMARION suggests, in a caprice of speculation it would seem, that the Martians are winged creatures, but whether bats, birds, or butterflies he does not attempt to decide.

There has been some speculation as to the possibility of establishing communication with our hypothetical neighbors, and some enthusiastic amateurs have reported glittering spots upon the planet’s disc, and have tried to interpret them as hailing signals from the distant world.

These “lights,” however, were, in all probability, mere reflections from favorably situated surfaces of the same material that compose the polar caps; and there is not the slightest probability that with any instruments we now possess we could distinguish any signals they could make. And if we could, who could read them?

Still, it is always wise to be reticent in denying the possibilities of the future, and no less so to be cautious in accepting as ascertained truth the startling conclusions and unverified discoveries of imaginative observers. It is so easy to see what one expects and wishes to find, especially on a disc so small and delicately marked as that of *Mars*.—*Boston Herald*, October 18, 1896.

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